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AN ANALYSIS OF INJURY DISTRIBUTION CHARACTERISTICS FOR SELECTED GROUND OPERATIONS

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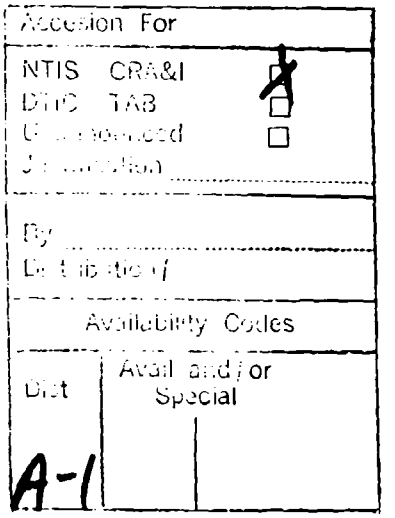

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SUMMARY

Problem

Medical resource planning requires projections of the anticipated incidence of traumatic battle injuries (BI) and non-battle injuries (NBI) likely to be sustained during a military operation. Further, the combat casualty care required depends upon the types of injuries incurred and the anatomical regions of the wounds.

Objective

The present investigation compares and contrasts traumatic injury distributions for selected combat operations dating from the Korean War. Differences in the distributions were expected to result from the nature of the military operations.

Approach

Medical admission data was analyzed for seven military operations: Desert Storm/Shield (the Gulf War); Operation Just Cause (Panama); Operation Corporate (Falkland Islands); Operation Urgent Fury (Grenada); operations in Lebanon; the Vietnam War; and the Korean Conflict. Frequency and percentage distributions by injury type and anatomy were determined for all operations. Chi-square analyses were performed to compare the distribution of injury types among the more recent combat operations.

Results

The distribution of injury types showed variability among all operations with significant variability among Operations Desert Storm/ Shield, Just Cause, and Corporate. Open wounds were the most prevalent BI injury type, while sprains/ strains/ dislocations and fractures accounted for the largest proportion of NBI injuries. Among anatomic distributions, extremity injuries were most prevalent for all operations.

Conclusions

The distribution of traumatic injuries, particularly injury type, varied among recent military operations. These variations were consistent with differences in the operational scenarios. Data pertaining to injury types and sites are needed adjuncts to established wounded-in-action and disease and non-battle injury rates, to enhance the accuracy of medical resource projections.

AN ANALYSIS OF INJURY DISTRIBUTION CHARACTERISTICS FOR SELECTED GROUND OPERATIONS

The treatment of traumatic injuries accounts for a substantial portion of the medical resources used during military operations. While rates of infectious disorders and other diseases may be higher than the incidence of physical traumas during a military engagement, injuries are far more resource-intensive in terms of the necessary health care personnel, lengths of treatment, and medical supplies and equipment. Consequently, medical planners need projections of the anticipated incidence of battle injuries (BI) and non-battle injuries (NBI) during combat operations in addition to the probable rates of disease occurrence.

Differences in enemy capabilities as well as the unique aspects of individual ground campaigns can potentially yield variations in injury distributions. For example, the Improved Fragmentation Munitions (IFM) which replaced random fragment munitions have a lower kill-to-wound ratio. IFM casualties will have dozens or even hundreds of wounds, and could increase demands on the medical system due to the extensive treatment they would require.[1] The Vietnam War, when compared to other engagements, saw a higher number of devastating maxillofacial and other multiple wounds which required specialized surgery and treatment.[2,3]

Forecasts of injury types and anatomical distributions are needed input to Department of Defense (DoD) models[4,5] which determine medical personnel and hospital bed type requirements. Information concerning the types of injuries likely to be sustained also can be used in the development and updating of combat surgery courses offered to military physicians.[6]

It was expected that the distribution of injuries would differ among military operations as a result of variations in combat elements such as tactical situation, geographical and climatological influences, weaponry, logistical support, and battlefield superiority. Therefore, the present study investigated injury types and anatomic distributions of casualties which were admitted to 3rd-echelon hospitals during various military operations since the Korean Conflict. The Vietnam War, the Falklands Conflict, Operations Just Cause (Panama) and Desert Shield/Storm, and actions in Grenada and Lebanon represent combat scenarios that may have relevance to future operations and were chosen for analysis. Examination of the traumas sustained in these operations should yield a comprehensive view of the types of injuries requiring treatment during varying combat scenarios. Previous studies have evaluated the overall wounded-in-action (WIA) and disease/non-battle injury (DNBI) rates during ground operations.[7,8,9] Analyses of injury distributions by type and anatomy, used as an adjunct to established WIA and DNBI rates, can enhance the capabilities of combat casualty projection models.

METHOD

Medical admission data was inspected for seven military operations: (1) Desert Storm/Shield (Gulf War); (2) Operation Just Cause (Panama); (3) Operation Corporate (Falklands); (4) Operation Urgent Fury (Grenada); (5) Lebanon operations; (6) the Vietnam War; and (7) the Korean Conflict.

The Gulf War refers to operations which took place in the Kuwaiti theater of operations from January 16 to February 22, 1991. Hospitalization records from fleet hospitals in the Gulf War (FH5 and FH15) were examined, and data on injury type and anatomic region were extracted for admissions of U.S. Marines with traumatic injuries.

The Panama data set comprises traumatic injuries sustained primarily by U.S. Army personnel during military operations in Panama from December 20 through December 31, 1989. These data were obtained from the hospitalization records for Wilford Hall Medical Center and Brook Army Medical Center, CONUS hospitals which served as 3rd echelon hospitals for the Panama operation.

The Falklands was a 25-day ground campaign occurring from May 21 through June 14, 1982. Traumatic injuries sustained by United Kingdom Amphibious Forces were extracted from medical logs and records maintained during this military operation.

The present investigation focused on conflicts in the Gulf, the Falklands, and Panama for two reasons: first, each had a comparable number of admissions available for analysis (Falklands=289; Panama=247; Gulf War=232); and second, they occurred most recently and thus may be most representative of future engagements. Chi-square analyses were performed to examine the differences between these operations in injury distributions.

Additionally, hospital admissions which resulted from operations in Grenada and Lebanon in late October, 1983 were extracted from a database maintained by the Naval Health Research Center.[10] Casualty statistics from Korea[11] and Vietnam[12] were also presented for comparative purposes.

Where possible, the data were classified to identify battle injuries (BI) and non-battle injuries (NBI). The NBIs were included in the analysis, first, because they impact operational medical resources although they are not directly caused by combat, and second, because the distinction between BIs and NBIs is not always clear during a military operation.

Admissions were analyzed for BIs, NBIs, and Total Injuries (combined BI and NBI) in terms of injury types and anatomy. Traumatic injuries were grouped into nine categories for each operation: Fractures, Burns, Sprains/ strains/ dislocations, Traumatic amputations, Concussions, Wounds, Contusions/abrasions/lacerations, Multiple injuries, and Other. Anatomical region was analyzed in terms of six body regions: Head, Upper extremities, Lower extremities, Trunk/neck, Multiple, and Other/unknown.

RESULTS

Operations Desert Storm/Shield, Just Cause, and Corporate

Injury Types. The frequencies of admissions by injury types which were available for the Gulf War, Panama, and the Falklands are shown in Table 1. For the Gulf War, BIs accounted for less than one-third (30.6%) of total traumatic injuries, while in the Falklands this proportion was 67.5 percent and in Panama the proportion recorded as BIs was 94.7 percent.

The BI distributions are shown in Figure 1. Open wounds represented the type of injury sustained most often as a result of combat in all three operations; the BI distribution from the Falklands indicated the highest proportion of open wounds (75.4%). Operations in the Gulf War also yielded a high proportion of open wounds (50.9%), while in Panama open wounds accounted for 42.7 percent of traumatic BIs. Burns accounted for 8.4 percent of BIs in the Gulf War; the proportion was lower in Panama (2.6%), and no burns were reported among ground troops in the Falklands. Also, the Falklands saw a relatively high proportion of amputations (7.7%) compared to the Gulf War (2.8%) and Panama (2.6%).

NBI injury distributions are seen in Figure 2. High numbers of (1) sprains/strains/dislocations and (2) fractures are evident, particularly in the distributions for the Falklands (44.7% and 21.3% respectively) and the Gulf War (41.0% and 31.7%). The proportion of NBI open wounds ranged from 23.1 percent in Panama to 11.8 percent in the Gulf War.

Total Injury distributions (BI + NBI) are shown in Figure 3. Open wounds were the most prevalent injury overall for all operations except for the Gulf War, where fractures and sprains/ strains/ dislocations were more typical than wounds.

Injury Type Chi-Square Analyses. Chi-square analyses for BI, NBI, and Total Injuries were performed for four injury categories. The first three, Open Wounds, Fractures and Sprains/ Strains/ Dislocations accounted for more than 80 percent of all injuries; the remaining injury types from Table 1 were aggregated to form the fourth category, 'Other'.

In the BI category, the Chi-square among the three injury types was highly significant (χ^2=66.584, p<.00001, df=6). In the Falklands the high frequency of open wounds combined with the low number of fractures and sprains/strains/dislocations contrasted significantly with the low open wound frequency and high numbers of fractures and sprains/strains/dislocations seen in Panama.

For NBIs, the Chi-square was not highly significant (χ^2=13.877, p < 0.05, df=6). Except for 'Other' injuries in Panama, occurrences in all categories across the three operations did not differ substantially from the expected values. Only 13 of the admissions in the Panama data set were recorded as NBIs; therefore, a Chi-square limited to the NBI data from the Gulf War and the Falklands was performed; this analysis was not significant (χ^2=3.396, p >.05, df=3).

The Chi-square was highly significant across trauma types among Total Injuries (χ^2=73.960, p<.00001, df=6). The high overall number of sprains/strains/dislocations and fractures along with the low occurrence of wounds seen in the Gulf War contrasted significantly with the low number of fractures and sprains/strains/dislocations and the high frequency of wounds which occurred in the Falklands.

Anatomic Region. Frequencies of anatomical site locations among available records from the Gulf War, the Falklands and Panama are shown in Table 2. Figure 4 displays the BI distributions for these operations. Lower extremity injuries accounted for a large proportion of BIs in Panama (52.1%) and the Gulf War (42.3%); the Falklands operation was characterized by a high number of multiple-site injuries (22.6%).

As seen in Figure 5, NBIs for all three operations most often affected either lower or upper extremities, accounting for more than half of the cases in the Falklands (66.0%) and the Gulf War (74.5%). Of the 13 NBI cases in the Panama database; 46.2 percent of these were injuries to extremities.

Anatomic distributions for Total Injuries, shown in Figure 6, similarly show a high incidence of extremity injuries. Most noteworthy among overall distributions is the high percentage of leg injuries sustained in the Panama operation (50.6%) and the Gulf War (46.6%).

Distributions for Grenada, Lebanon, Vietnam, and Korea

Distributions of injury types and anatomic regions for Grenada, Lebanon, Vietnam, and Korea are shown in Tables 3 and 4, respectively. The data sets were small for Grenada (n=15) and Lebanon (n=64) and are presented for informational purposes; however, both show large proportions of open wounds and fractures which mainly affected lower and upper extremities.

Admissions during Vietnam (n=70,943) and Korea (n=107,850) provide large samples for comparative purposes. Among combined BI and NBI injury types, Vietnam in particular saw a high percentage of open wounds (61.7%) compared to other distributions. Among anatomic regions, both Korea and Vietnam show high frequencies of injuries affecting upper or lower extremities. A salient feature of these data, however, is the extremely high proportion of traumas to multiple anatomic regions seen in Vietnam (26.0%).

DISCUSSION

The distributions of traumatic injuries, as well as the anatomic regions affected have shown considerable variability in the ground combat operations examined dating back to the Korean War. These differences can be explained by considering factors such as weapons involved, tactical situation, combat intensity, enemy capability, weather, and geography. For example, the high proportion of lower extremity injuries seen in Panama is attributable to airborne invasion tactics, while the high proportion of open wounds sustained in Vietnam, the Falklands and Desert Storm/Shield is reflective of weaponry such as guns, mortars, and mines which characterize ground warfare.[3] In addition, differences in record-keeping, length of the engagement, and distance of the military operation from home are possible reasons for the wide range in the ratio of BI to NBI admissions in the Gulf War, the Falklands and Panama.

Medical doctrine may also play a role in determining injury distributions at 3rd echelon facilities. The policy of evacuating burn casualties immediately to the rear during Desert Storm/Shield,[14] for instance, is one feasible explanation for the elevated proportion of burns seen there as compared to other operations.

The casualty care provided during the Vietnam conflict was the most highly developed in comparison to the other conflicts.[3,14,15] Factors which contributed to that level of medical support, such as battlefield control, a superbly-equipped hospital close to the battle area, and essentially unfettered logistical support, may never again converge in a single operation.[16] It is more likely that future operations will have greater similarities to Desert Storm, the Falklands, Grenada, or Just Cause. Although they were smaller in scale and shorter in duration than Korea

or Vietnam, casualty data from these engagements can be useful as an adjunct to projected casualty rates for determining needed medical resources.

Medical readiness planning is an important undertaking because it ensures that appropriate medical personnel and supplies will be available during combat operations.[17] As computer simulation capabilities expand, it is possible to incorporate an increasing number of factors as input to medical requirements models and thus enhance their forecasting accuracy. Efforts to improve casualty projections for military operations can further optimize the medical personnel, equipment and supplies deployed to a theater of operations and ensure that sufficient resources are available for the treatment of wounded personnel.

REFERENCES

1. Smith AM: What makes war surgery different? *Military Medicine* 156(1):33-35, 1991.

2. Jacob E: Infection in war wounds: experience in recent military conflicts and future considerations. *Military Medicine* 154(17):311-315, 1989.

3. Custis DL: Military medicine from World War II to Vietnam. *Journal of the American Medical Association* 264(17):2259-2262, 1990.

4. Systems Research and Applications Corporation: Preliminary software requirements for the Medical Planning and Execution System of Joint Operation Planning and Execution System. TR-91-674-0234.1, January 1992.

5. Galarza JG: Using the Deployable Medical Systems Clinical Data Base for Materiel Requirements. Presentation to Army Operations Research Symposium (AORS XXVI), October, 1987. Fort Lee, VA.

6. Rignault DP: How to train war surgery specialists: Part II. *Military Medicine* 155(4):143-147.

7. Kuhn GWS: Ground forces battle casualty rate patterns:suggested planning considerations. Report FP703TR3. Logistics Management Institute, Bethesda, MD, 1991.

8. Blood CG, Gauker ED, Jolly R, Pugh WM: Comparisons of medical presentation and admission rates during various combat operations. *Military Medicine*, in press, 1994.

9. Blood CG, Gauker ED, Anderson ME, Odowick MS, O'Donnell ED. Projections of battlefield medical casualties among U.S. Marine forces for various theaters of operations. Report 93-35. Naval Health Research Center, San Diego CA, 1993.

10. Garland FC, Helmkamp JC, Gunderson EKE, Gorham ED, Miller MM, McNally MS, and Thompson FA. A guide to the computerized medical data resources of the Naval Health Research Center. Report 87-13. Naval Health Research Center, San Diego CA, 1987.

11. Reister FA: Battle Casualties and Medical Statistics; U.S. Army Experience in the Korean War. Surgeon General, Department of the Army. Washington, D.C., 1973.

12. Blood CG, Nirona CB, Pederson LS: Medical resource planning: the need to use a standardized diagnostic system. Report 89-41. Naval Health Research Center, San Diego, CA, 1989.

13. Sved, L: Inter-operability of health services of the Coalition forces: the Hungarian military hospital's experience in the Persian Gulf War. *Military Medicine* 159(2):95-98, 1994.

14. Bellamy RF: The causes of death in conventional land warfare: implications for combat casualty care research. *Military Medicine* 149(2):55-62, 1984.

15. Rignault DP: Is war surgery a specialty? Part I. *Military Medicine* 155(3):91-97, 1990.

16. Lund PW: Medical support for future combat. *Naval War College Review* 45:81-92, Spring, 1992.

17. Bowersox JC: Data-based resource planning for battlefield trauma management. *Military Medicine* 156(6):300-305,1991.

Table 1.
Frequencies of Injury Types for
the Falklands, Panama, and Desert Storm

	Falklands			Panama			Desert Storm			Combined		
Injury Type	BI	NBI	Total	BI	NBI	Total	BI	NBI	Total	BI	NBI	Total
Open Wounds	147	14	161	100	3	103	36	19	55	283	36	319
Fractures	15	20	35	62	3	65	10	51	61	87	74	161
Sprains/Strains/Disloc.	2	42	44	33	1	34	8	66	74	43	109	152
Contus./Abras./Lacer.	11	7	18	23	2	25	1	9	10	35	18	53
Other	3	5	8	2	1	3	8	7	15	13	13	26
Burns	0	0	0	6	0	6	6	8	14	12	8	20
Amputations	15	1	16	1	0	1	2	0	2	18	1	19
Multiple	0	2	2	6	2	8	0	0	0	6	4	10
Concussions	2	3	5	1	1	2	0	1	1	3	5	8
Total	195	94	289	234	13	247	71	161	232	500	268	768

Table 2.
Frequencies of Anatomic Region of Casualties for
the Falklands, Panama, and Desert Storm

	Falklands			Panama			Desert Storm			Combined		
Anatomic Region	BI	NBI	Total	BI	NBI	Total	BI	NBI	Total	BI	NBI	Total
Lower Extremities	51	51	102	122	3	125	30	78	108	203	132	335
Upper Extremities	37	11	48	33	3	36	23	42	65	93	56	149
Trunk/Neck	35	23	58	40	3	43	3	18	21	78	44	122
Multiple	44	1	45	23	1	24	10	10	20	77	12	89
Head	24	8	32	13	3	16	4	12	16	41	23	64
Other/Unknown	4	0	4	3	0	3	1	1	2	8	1	9
Total	195	94	289	234	13	247	71	161	232	500	268	768

Table 3.
Distributions of Injury Types for
Vietnam, Korea, Grenada, and Lebanon

Injury Type	Grenada N=15	Lebanon N=64	Vietnam N=70,943	Korea N=107,850
Open Wounds	26.7%	46.9%	61.7%	47.9%
Fractures	26.7%	20.3%	17.9%	22.8%
Sprains/Strains/Disloc	6.7%	-0-	7.0%	8.2%
Contus./Abras./Lacer.	20.0%	10.9%	2.8%	8.1%
Other	-0-	7.8%	3.4%	6.4%
Burns	-0-	-0-	2.8%	3.3%
Amputations	20.0%	-0-	1.8%	1.4%
Multiple	-0-	12.5%	1.0%	-0-
Concussions	-0-	1.6%	1.6%	1.8%
Total	100.0%	100.0%	100.0%	100.0%

Table 4.
Distributions of Anatomic Region of Casualties for
Vietnam, Korea, Grenada, and Lebanon

Anatomic Region	Grenada N=15	Lebanon N=64	Vietnam N=70,943	Korea N=107,850
Lower Extremities	26.7%	21.9%	29.0%	36.3%
Upper Extremities	40.0%	23.4%	19.7%	29.0%
Trunk/Neck	13.3%	6.3%	9.1%	18.2%
Multiple	6.7%	12.5%	26.0%	n/a
Head	13.3%	28.1%	14.2%	16.2%
Other/Unknown	-0-	7.8%	1.9%	0.3%
Total	100.0%	100.0%	100.0%	100.0%

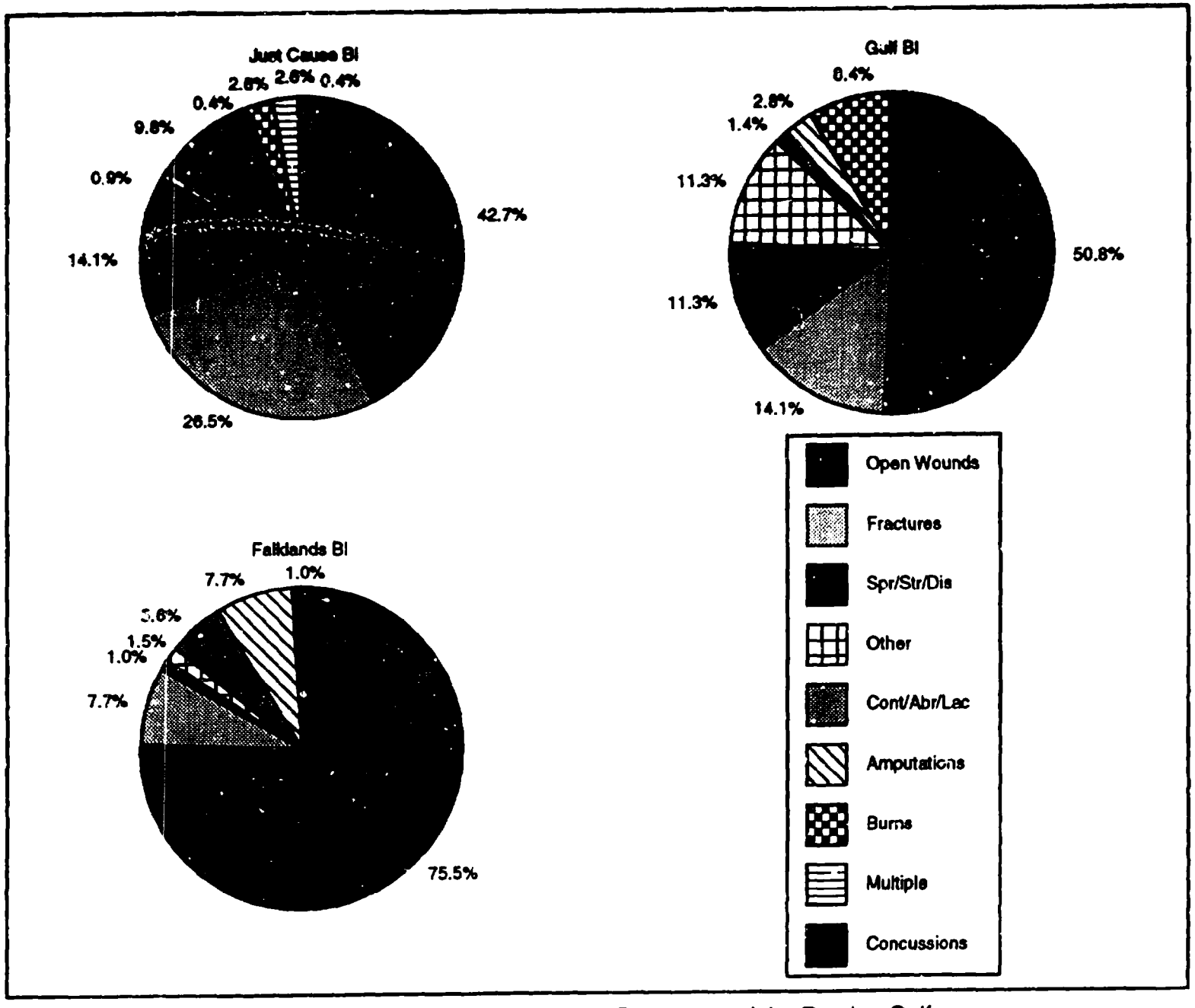

Figure 1. BI injury distribution for Falklands, Panama, and the Persian Gulf

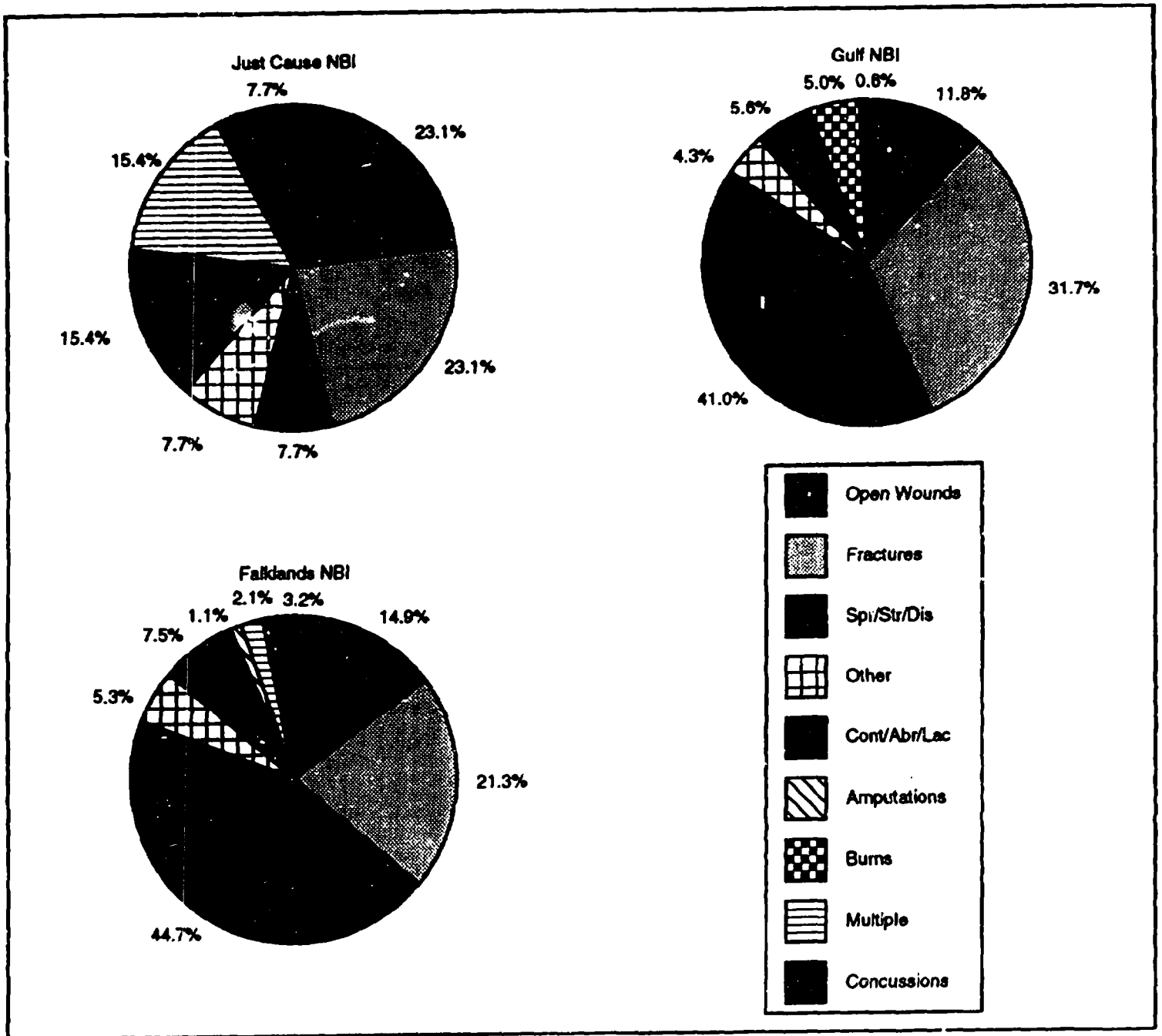

Figure 2. NBI injury distributions for Falklands, Panama, and the Persian Gulf

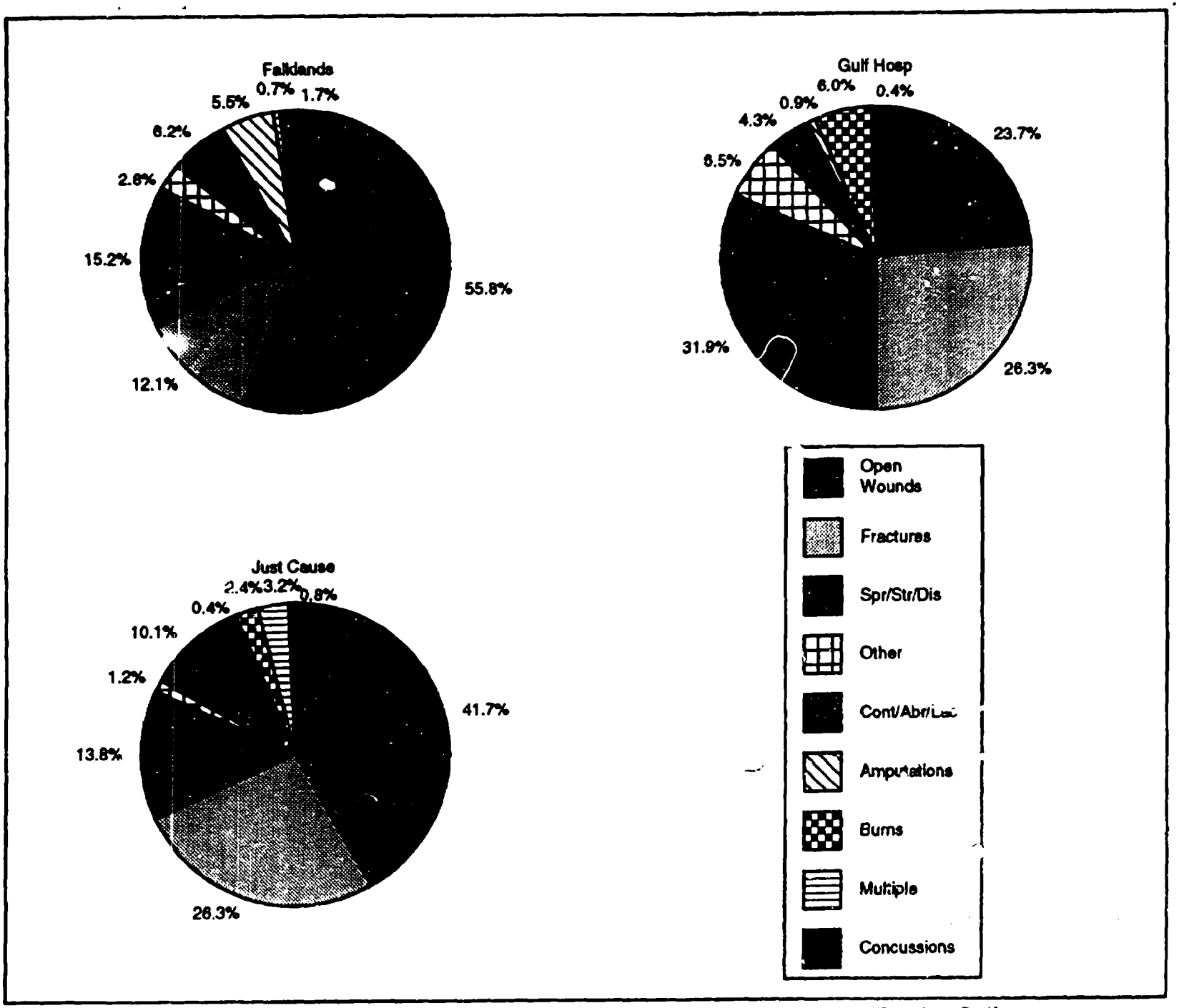

Figure 3. Combined BI and NBI injury distributions for Falklands, Panama, Persian Gulf

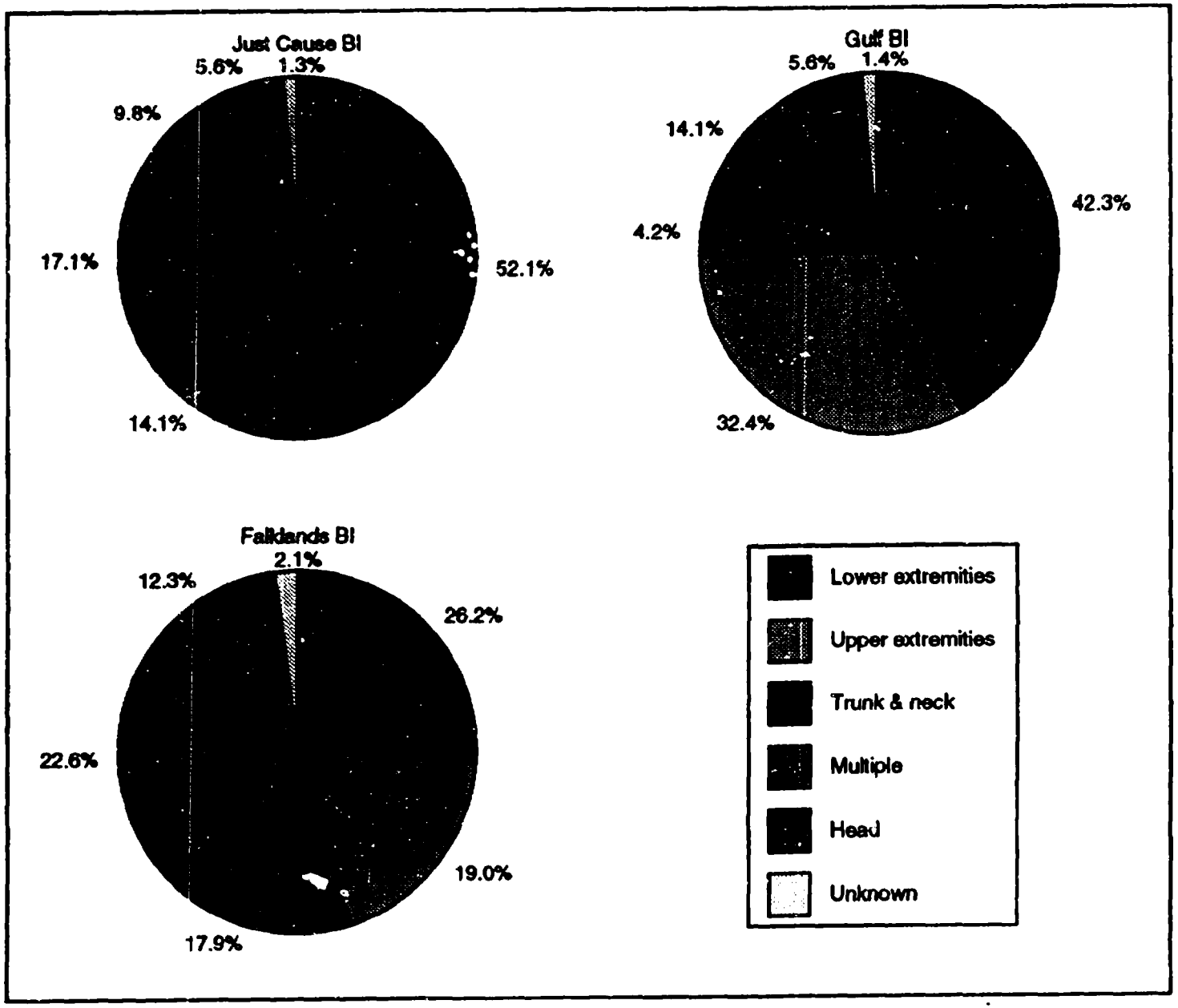

Figure 4. BI anatomical region distributions for Falklands, Panama, and Desert Storm

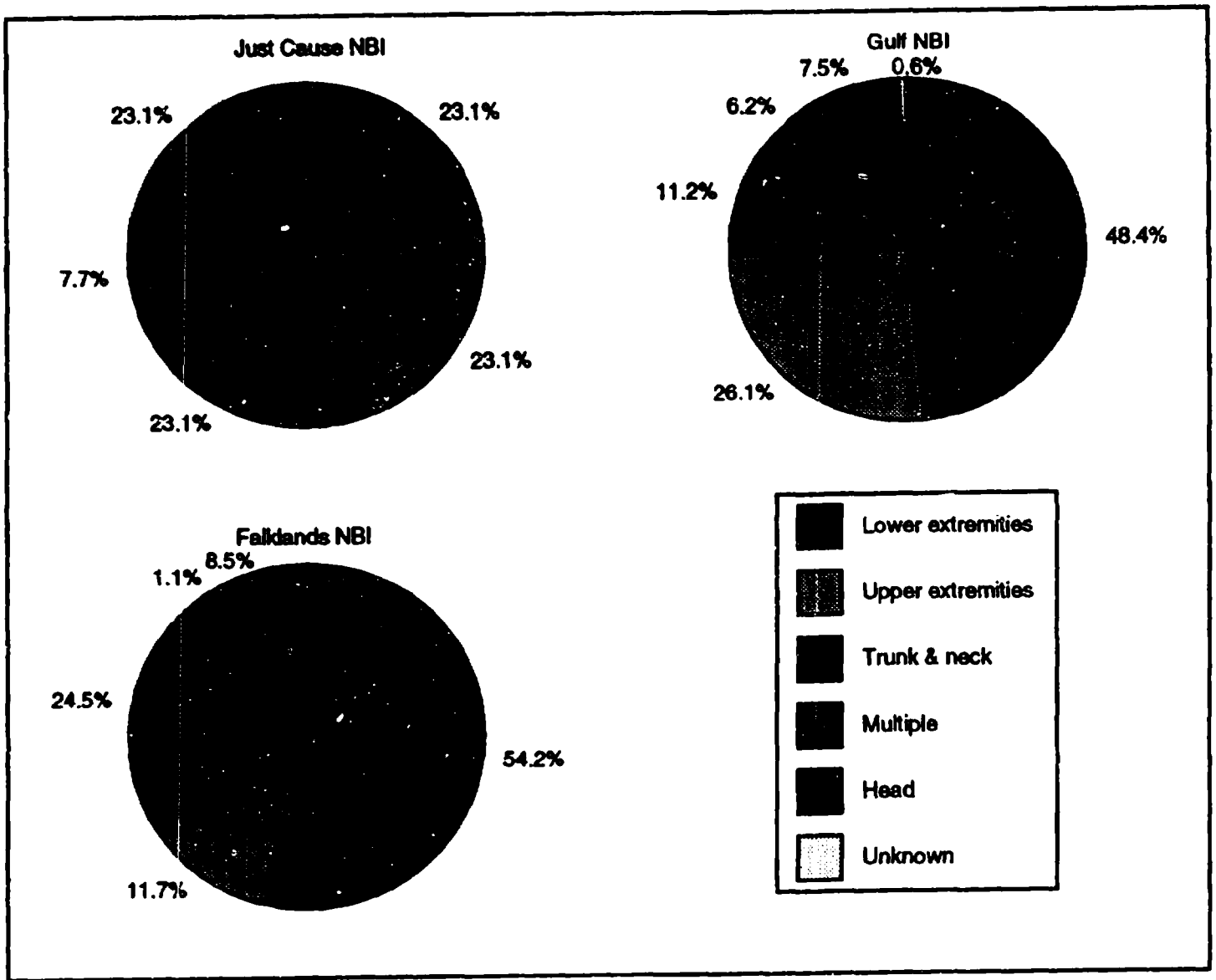

Figure 5. NBI anatomical region distributions for Falklands, Panama, and Desert Storm

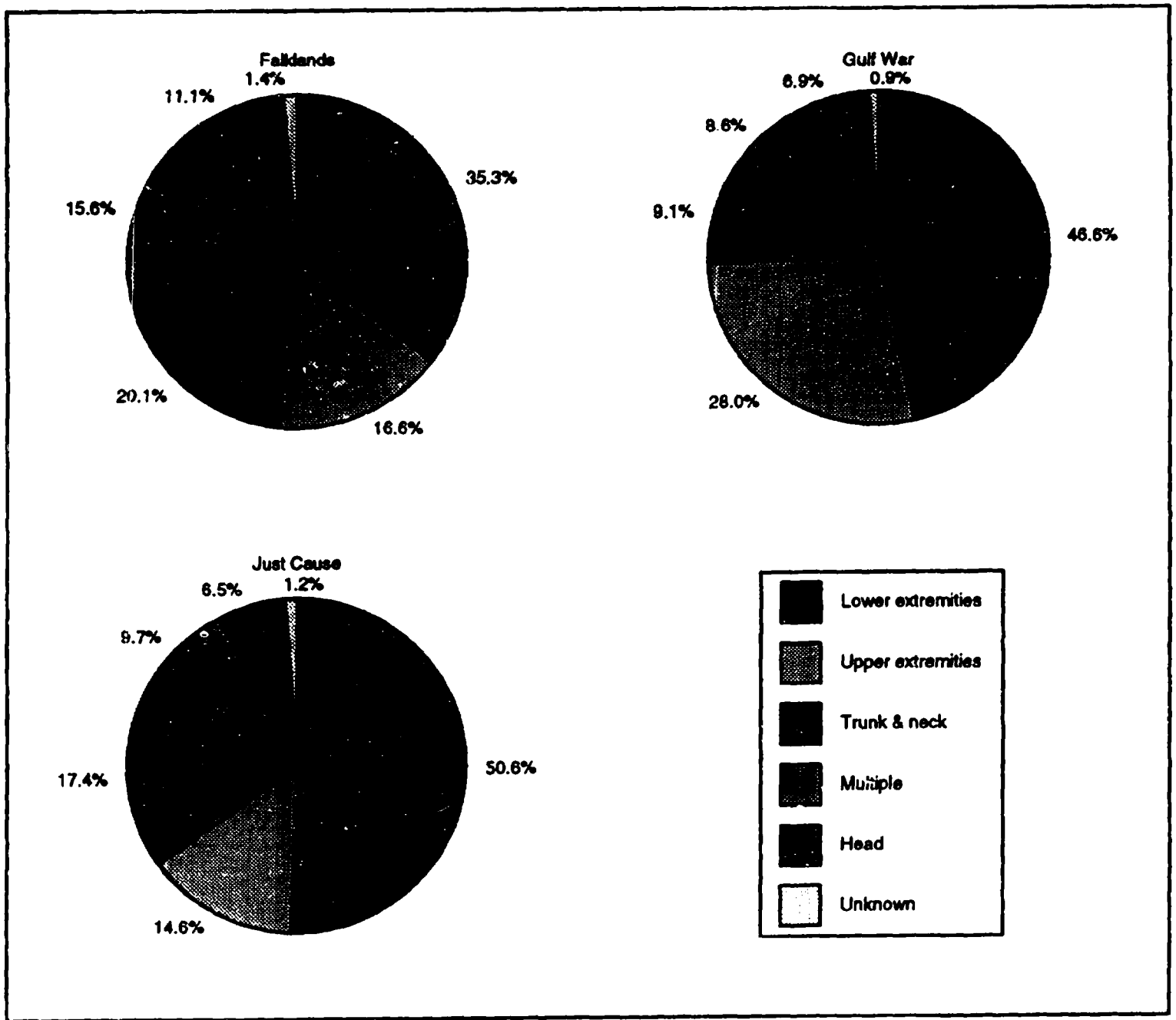

Figure 6. Combined BI and NBI anatomical region distributions for Falklands, Panama, Desert Storm

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13. ABSTRACT *(Maximum 200 words)*

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